



The Effect of Environment Perception Preferences on Psychological Restoration of Older Adults in the Severe Cold Region

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Abstract

Background: Mental health issues are increasingly prevalent in older adults as the population ages. The relationship between psychological restoration and environmental perception preferences in older adults residing in the severe cold region is investigated in this study.

Methods: Six urban public areas in severe cold regions were selected as research sites, and 1093 older adults were surveyed using a questionnaire in this investigation. The questionnaire included an environmental perception preference scale and the Restorative Outcome Scale.

Results: Environmental perception preferences substantially influence psychological restoration in older adults ($\eta^2 = 0.130$, $P < 0.001$), and a notable interaction is observed between perception preferences and seasonal variations ($\eta^2 = 0.065$, $P < 0.001$). Preferences for vegetation exert the most substantial positive influence on psychological restoration during spring and summer. In winter, preferences for recreational activities are paramount; whereas in autumn, preferences for people are identified as critical for psychological restoration.

Conclusion: In severe cold regions, psychological restoration is influenced not only by environmental perception preferences but also by climate fluctuations. This study provides valuable insights, assisting designers in developing restorative environments for older adults residing in severe cold areas.

Keywords: Psychological restoration; Older adults; Urban public space; Environment perception preference; Severe cold region

Introduction

A total of 809 million individuals were 60 or older globally in 2023, constituting 14% of the world's population, increasing from 11% in 2013 (1). Mental health issues increasingly affect older

adults, and approximately 15% are experiencing conditions, such as despair, anxiety, and mood disorders (2). Urban older adults are at a great risk of developing mental health conditions, in-



cluding anxiety, depression, and addiction, compared with those in rural areas (3, 4). Ongoing urban expansion leads to increasing estrangement from natural areas, negatively affecting mental health (5, 6). Additionally, adverse psychological conditions, such as anxiety and stress, are exacerbated by environmental factors associated with urbanization, including the urban heat island effect, air pollution, and noise (7-9).

Mental health issues in older adults can be effectively addressed in urban public spaces. Physical areas for exercise and relaxation provided by these spaces improve mood, relieve stress, and enhance physical and mental health (10). Additionally, public spaces play an essential role in social interactions and community activities, thereby reducing the loneliness and social isolation of older adults (11, 12). During cold winter months, the outdoor activities of older adults are often reduced due to harsh weather conditions. However, urban spaces offer various opportunities for physical activity, leisure, and socialization. Enhancing public space environments in urban areas is one of the most effective ways to boost the mental health of older adults residing in severely cold regions (13-15).

Perceived preferences are known to substantially influence psychological states and health in diverse urban environments (16), exerting a considerable effect on the psychological restoration of older adults in public spaces during cold weather (17, 18). This phenomenon is explained by Stress Reduction Theory (SRT) and Attention Restoration Theory (ART). SRT suggests that natural environments can inadvertently reduce individual stress (19, 20), whereas ART proposes that such settings facilitate attention restoration through unconscious and cognitive mechanisms (21, 22). Urban parks or green spaces rich in natural elements are usually preferred because these environments evoke heightened sensations of "restoration," including tranquility, relaxation, and joy (23, 24). This preference enables individuals to benefit from natural environments, aiding in the replenishment of mental and physical resources depleted by daily stress (25). Conversely, low levels of preference may lead to insufficient

recuperation and increased psychological stress in artificial, noisy, or congested urban settings (26). Specific urban public spaces' environmental characteristics that substantially influence psychological restoration remain unidentified, and studies comparing perceptual preferences associated with different environmental elements are limited. Some physical environmental factors, such as green space (27), and the effects of social interaction and physical activity (28) have been comprehensively examined, but research on the interplay of diverse environmental elements, including their perceived preferences and relative importance in psychological restoration, is insufficient. Additionally, a substantial portion of recent research focuses on students and young demographics, and few studies considers older individuals (29-31). Diverse demographic groups are likely to exhibit markedly different preferences for identical sceneries (32, 33). With aging, individuals often experience considerable changes in physical and mental health, such as the onset of chronic illnesses, impairments, and declines in vision and hearing (34), which may affect psychological well-being and perceived preferences.

In conclusion, examining the correlation between the psychological restoration of older adults and their perceived preferences is expected to provide theoretical rationale and targeted practical guidance for urban environmental design in severely cold regions.

The following questions are addressed in this study: Firstly, is psychological restoration in older adults in a severely cold region considerably influenced by their perceived preferences for urban public spaces? Secondly, which environmental perception preference has the most considerable effect on the psychological restoration of older individuals in severely cold climates? Lastly, do these influences fluctuate with the season?

Materials and Methods

Selection of Urban Public Spaces

Harbin, which is a representative city in an extremely cold region, was selected. Substantial seasonal temperature variations in the city provided

a unique context for examining the effect of environmental factors on psychological restoration in older individuals. Field experiments were con-

ducted from December 2020 to December 2021, and extensive data were collected across all four seasons (Table 1).

Table 1: Thermal Environment Characteristics in Different Seasons

Season	Average Air Temperature (°C)	Average Relative Humidity (%)
Spring	22.38	30.1
Winter	- 10.07	58.31
Autumn	12.99	39.13
Summer	29.11	64.16

Note: All data were obtained through field measurements using the BES-01 temperature recorder

Six measurement sites, including parks, streets, and residential community squares, were selected according to the diversity and representativeness of urban public spaces (Fig. 1). This extensive array of locations offered a comprehensive environment for investigating the effects of environ-

mental elements on psychological restoration in older individuals. Fig. 1 presents the distribution of each measurement point and corresponding fisheye photographs, using summer as an example.

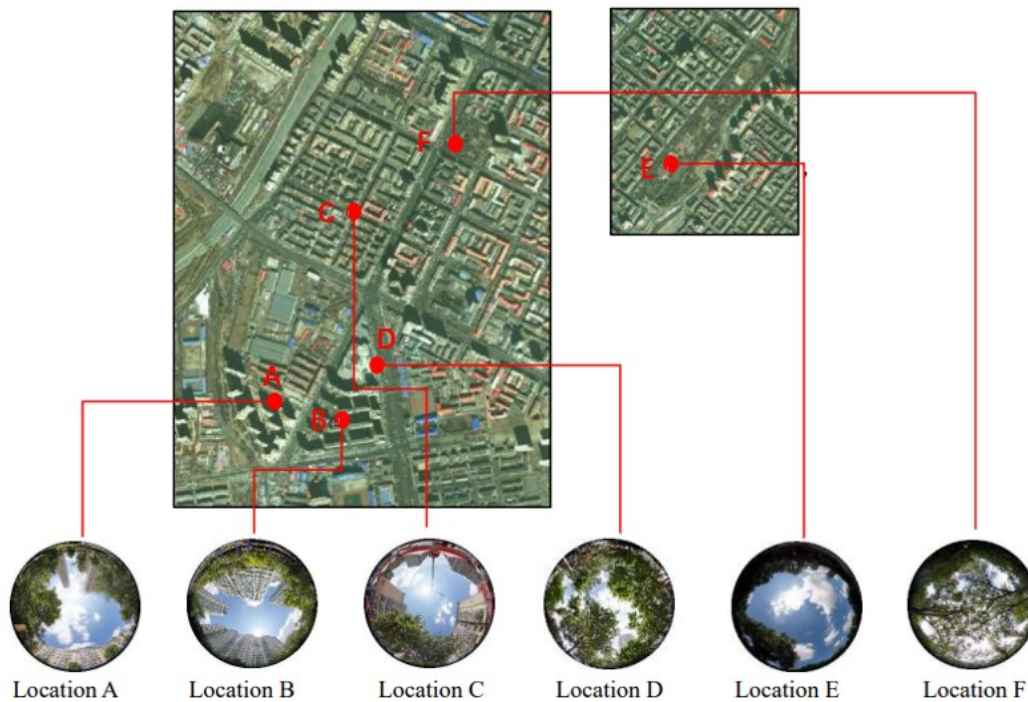


Fig. 1: Distribution of measurement points and environmental characteristics

Environmental Factors

Urban public spaces are frequently shaped by landscape features, facility configurations, and human activities, all of which affect physical and

mental health (35, 36). Two categories of landscape features were recognized: artificial and natural landscapes. In urban greening and open

spaces, natural landscape components include vegetation and elements, such as trees, flowers, and the sky. These natural components positively influence mental health by providing psychological and visual healing experiences (37). Structures, such as buildings, roads, and squares, and other artificial, and nonbiological entities are referred to as artificial landscapes. Through diverse layouts and designs, these components provide the essential framework of urban regions and profoundly affect environmental aesthetics and user experiences (38). Facility configurations, including amenities, such as seats and fitness equipment commonly used by older adults, are regarded as essential elements of urban public spaces. These amenities offer valuable locations for relaxation and exercise and may encourage social interactions and recreational activities, potentially benefiting psychological restoration (39). Finally, human activity is considered an important factor influencing environmental conditions, and particular attention is given to people and recreational activities and their potential effects on psychological restoration.

Questionnaire Survey

The effects of environmental perception preferences on psychological restoration were examined using on-site questionnaire surveys, and respondents were randomly selected at each of the six measurement locations. The questionnaire was systematically divided into three sections, and data on participants' perceived preferences and psychological restoration in various environmental contexts were obtained. The first section collected demographic information, including respondents' gender, age, educational attainment, and duration of residency. The second section assessed the views and preferences of the respondents regarding environmental factors in urban public areas. Two measurement techniques were utilized. A five-point Likert scale (1 signifies "strongly dislike" and 5 signifies "strongly like") was used in assessing overall preferences regarding environmental perceptions. A binary method was used in evaluating preferences for specific environmental elements ("like" or "dislike"). In

the third section, the participants' subjective evaluations of psychological restoration were measured using the Restorative Outcome Scale (ROS) (40, 41). The mean scores of each item were calculated and used in determining the overall level of psychological restoration. This assessment utilized a five-point Likert scale, where 1 indicates "disagree" and 5 indicates "agree". This study was approved by the Degree Committee of the School of Architecture at Harbin Institute of Technology, which includes an ethics review committee.

A total of 1157 participants completed the questionnaire survey, yielding 1093 valid responses and a response rate of 94.5%. The distribution of valid samples was as follows: 240 in fall, 380 in winter, 244 in summer, and 229 in spring. Participants aged 60–94 (mean age $M = 70.0$, standard deviation $SD = 7.57$), and 56.3% identified themselves as males.

Results

Comprehensive statistical analysis and modeling of collected data were conducted using IBM SPSS Statistics 26 and Python 3.1.0. One-way ANOVA was initially performed for the evaluation of the seasonal effects of perceived preferences on psychological restoration in older adults. The influences of environmental factors on perceived preferences were subsequently analyzed using independent-samples t-tests. The primary variables influencing the psychological restoration were identified using a constructed random forest model, which assessed the relative significance of various environmental factors. Additionally, accuracy and robustness in results regarding relative significance were ensured by refining the parameters of the model with grid search and 10-fold cross-validation methods.

Seasonal Effects of Perception Preferences on Psychological Restoration

The one-way ANOVA results indicated that perceived preferences significantly influenced psychological restoration in older adults ($F = 26.661$,

$P < 0.001$, $\eta^2 = 0.130$), suggesting that perceived preferences constituted a crucial element in psychological restoration (Table 2). However, the primary effect of a seasonal component on psychological restoration was nonsignificant ($F = 0.795$, $P = 0.497$, $\eta^2 = 0.002$), indicating that sea-

sons did not substantially influence psychological restoration in older individuals. The influences of preferences fluctuated with season, as evidenced by the significant interaction effect between perceived preferences and season ($F = 6.722$, $P < 0.001$, $\eta^2 = 0.065$).

Table 2: Influence of seasons and perception preferences on psychological restoration

Factor	F	P	Effect size (η^2)
Perception preferences	26.661	<0.001	0.130
Season	0.795	0.497	0.002
Perception preferences*Season	6.722	<0.001	0.065

Effects of Perceived Preferences for Landscape Features on Psychological Restoration

The results of the independent samples *t*-tests (Fig. 2) indicated that the reported benefits of various landscape elements for the psychological restoration of older adults varied significantly by season. Perceived preferences for the sky had the most significant effect on psychological restoration in autumn (Fig. 2a). Compared with participants who “disliked” the sky, those who appreciated the autumn sky showed 0.454 reduction in ROS scores, suggesting that urban public spaces are less effective in restoring psychological well-being during this season. Conversely, perceived preferences for vegetation demonstrated substantial benefits during spring and winter (Fig. 2b). In spring, a preference for vegetation increased ROS scores by 0.465, and in winter, the scores increased by 0.279. However, perceived preferences for artificial landscapes (such as buildings and roads) were not significantly influenced by

any season (Figs. 2c and 2d). This result suggested that psychological restoration in older adults might not have been as significantly affected by artificial landscapes as it was by natural landscapes.

Effects of Perceived Preferences for Facility Configurations on Psychological Restoration

Psychological restoration in older individuals was significantly influenced by their perceived preferences for different facilities (Fig. 3). In particular, psychological restoration was significantly affected by perceived preferences for seats in spring, winter, and autumn (Fig. 3a). During these seasons, the ROS scores increased by 0.293, 0.191, and 0.212, respectively, due to a preference for seats. Similarly, perceived preferences for fitness equipment showed significant effects during winter and autumn (Fig. 3b). In these seasons, the ROS scores increased by 0.252 and 0.150, respectively, due to a preference for fitness equipment.

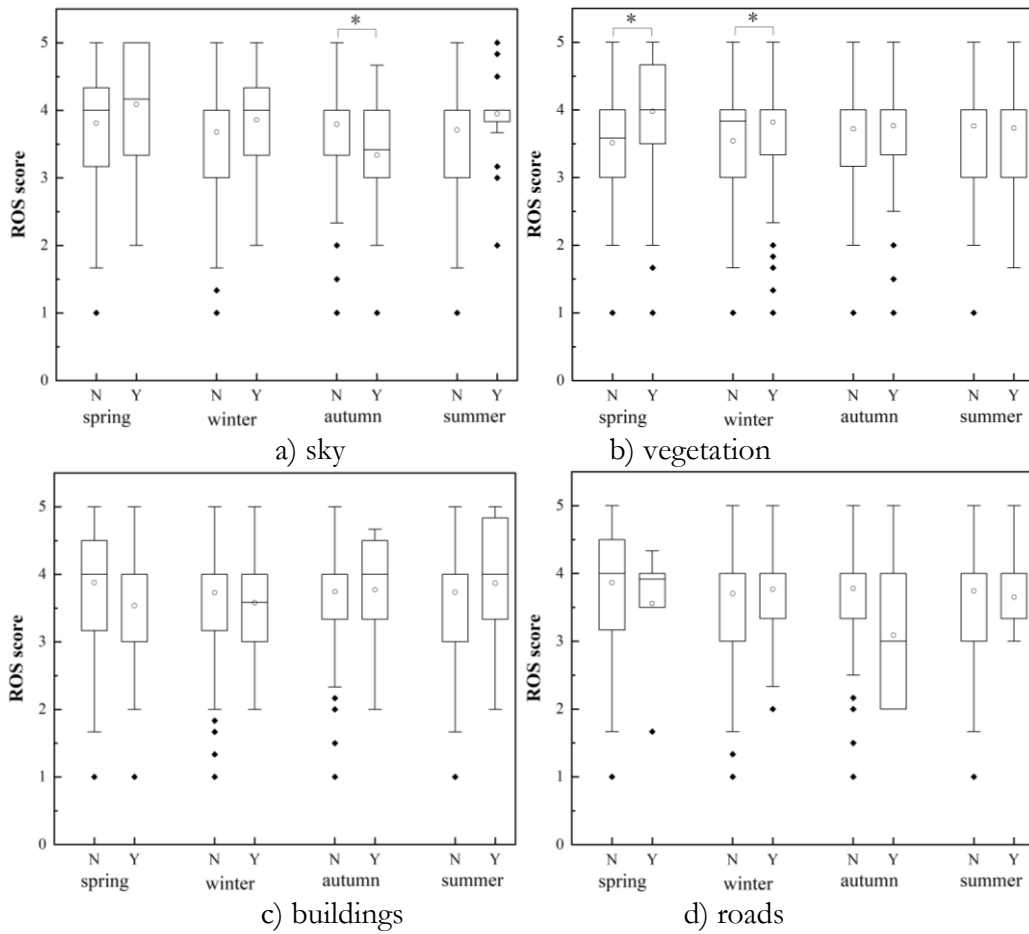


Fig. 2: Effects of Landscape Features on Psychological Restoration

Note: N denotes "dislike" for perceived preferences; Y denotes "like" for perceived preferences; * indicates statistical significance ($P < 0.05$)

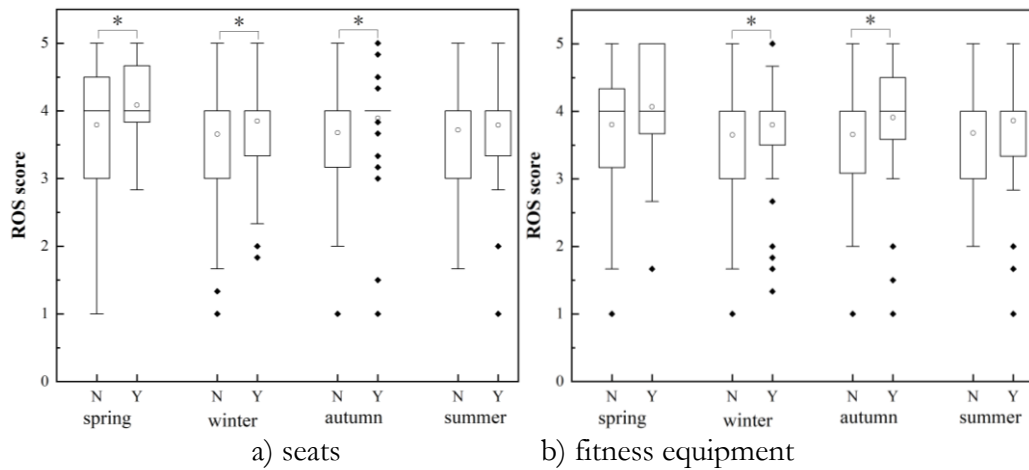


Fig. 3: Effects of Facility Configurations on Psychological Restoration

Note: N denotes "dislike" for perceived preferences; Y denotes "like" for perceived preferences; * indicates statistical significance ($P < 0.05$)

Effects of Perceived Preferences for Human Activities on Psychological Restoration

Psychological restoration in older adults during winter and autumn was significantly influenced by their perceived preferences for human activities (Fig. 4). In particular, a preference for the presence of people significantly contributed to psychological restoration during these seasons (Fig. 4a). In winter, the ROS scores increased by 0.163 due to the preference for “like” people, and

in autumn, the scores increased by 0.361. Additionally, substantial fluctuations were observed in perceived preferences for recreational activities during winter and autumn (Fig. 4b). The “like” preference for recreational activities increased the ROS scores by 0.295 and 0.300 in winter and autumn, respectively. Overall, these findings highlighted the significance of human activities, particularly social interaction and recreational activities, in supporting the mental well-being of older individuals.

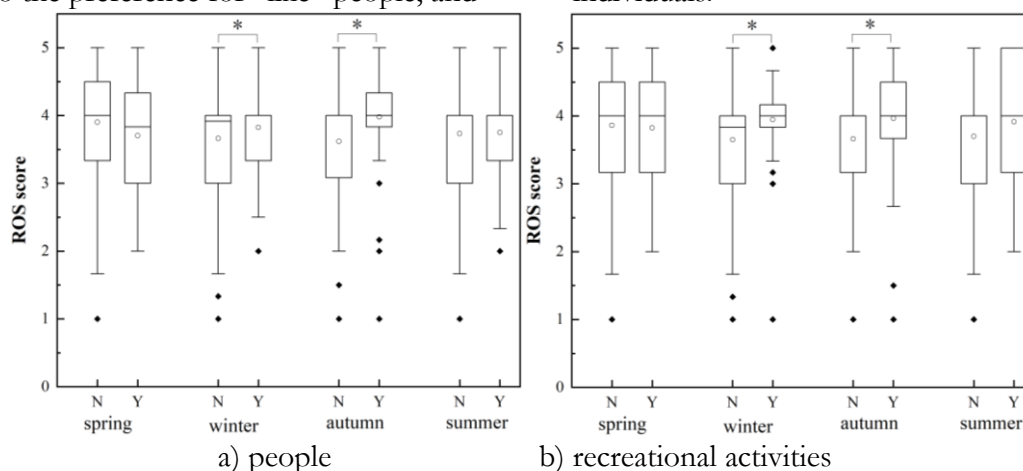


Fig. 4: Effects of Human Activities on Psychological Restoration

Note: N denotes "dislike" for perceived preferences; Y denotes "like" for perceived preferences; * indicates statistical significance ($P < 0.05$)

Relative Importance of Perceived Preferences for Environmental Factors in Psychological Restoration

A random forest model was employed to determine the relative relevance of perceived preferences for environmental factors that influenced psychological restoration in older adults across seasons (Fig. 5). Significant seasonal variations were identified.

In winter, spring, and summer, psychological restoration in older adults was most significantly influenced by perceived preferences for landscape features. The highest significance was observed in winter (44.61%), and the sky (13.03%) and vegetation (17.45%) contributed the most to psychological restoration. This finding suggested that during the winter months, older individuals

relied more heavily on natural landscapes to support their mental health. Although a slight decrease in the importance of landscape features was noted in spring (41.09%), it remained the highest factor, and vegetation (30.16%) exerted a significant influence on psychological restoration. By contrast, the importance of facility configurations increased substantially in spring (36.21%), particularly seats (22.81%), indicating that older individuals were more likely to utilize outdoor spaces and natural settings for mental health rehabilitation when temperatures are favorable. The relative importance of landscape features remained high in summer (37.67%), especially for the sky (19.62%) and vegetation (9.60%), whereas perceived preferences for human activities increased significantly (31.71%). This trend sug-

gested that the psychological rejuvenation of older individuals during hot seasons was achieved through a combination of social activities and interactions with natural elements.

Autumn was distinct from the other three seasons. Perceived preferences for human activities were the most significant during this season (42.39%), and preference for people (31.32%)

had the largest effect. This result suggested that older individuals were more inclined to engage in social activities that supported psychological restoration in autumn. By contrast, the importance of landscape features (27.74%) and facility configurations (29.87%) was relatively modest, and minor effects were observed for buildings (6.57%) and vegetation (9.62%).



Fig. 5: Relative Importance of Environmental Perceived Preferences

Discussion

Previous research primarily focuses on individual environmental elements, and limited consideration is given to the effects of varying environmental perception preferences. A gap in the literature is addressed by quantifying the specific contributions of various environmental factors in urban public spaces in cold regions to psychological restoration using a random forest method. Seasonal differences are comprehensively assessed, and the role of vegetation in supporting psychological restoration is thoroughly investigated.

Vegetation perception preference has the highest contribution to psychological restoration across all seasons, with the largest effect observed in spring. This result supports the notion that vividly colored flowers in spring can greatly enhance aesthetic preferences and facilitate psychological healing, as evidenced already (42, 43). Notably,

psychological restoration is significantly influenced by vegetation perception preference even when foliage is obscured by snow during the winter months. This finding corroborates the hypothesis proposed by Hidalgo et al. (31), who proposed that winter vegetation can effectively facilitate psychological restoration. Interestingly, the contribution of winter vegetation exceeds that of summer vegetation, aligning with the findings of Zhu et al. (44), who emphasized the seasonal significance of vegetation. By contrast, the effect of vegetation perception preference on psychological restoration in fall is not statistically significant, differing from the research of Kuper (45), who suggested that the change in the hues of leaves from green to red and yellow in fall can enhance psychological restoration. This disparity may be attributed to the demographics of the sample populations and the unique environmental conditions of cold climates. Additionally, the psychological restoration of older individuals is

significantly influenced by their perception preference for the autumn sky. This finding contrasts with the findings of Lu et al. in Tokyo, where vegetation has a less significant effect (35). These variations suggest that environmental perception preferences in harsh climates differ significantly from those in other regions, underscoring the need for region-specific research.

People and entertainment activities constitute the second most influential factor in psychological restoration during autumn and winter, following greenery. Alignment with the results of Bai et al. (46) is observed, who demonstrated that the psychological recuperation of older adults is more significantly influenced by crowd activities in summer and highlighted seasonal variations in older adults' preferences for environmental perception. Furthermore, seat arrangements are indispensable for psychological recuperation because they provide opportunities for relaxation and considerably enhance the capacity of older adults for concentration, thought, and relaxation. The conclusion corroborates the findings of Lu et al. (35) in Tokyo and provides valuable guidance for the development of age-friendly public spaces. Notably, Zhu et al. (44) found a significant negative effect of crowds on psychological restoration during winter; this effect is possibly due to the focus on younger participants in their study. By contrast, results focusing on older individuals reveal that community activities facilitate psychological restoration within preferred social environments, particularly during winter and autumn. A sharp contrast with the results of Zhu et al. (44) is observed, highlighting disparities in psychological restoration and environmental perception among different age groups. Consequently, to ensure that public spaces can more effectively support psychological restoration for diverse populations (47, 48), the employment of design strategies tailored to the specific needs of various age groups and occupational groups is essential in the development of public spaces in cold cities.

Conclusion

The seasonal effects of environmental perception preferences in urban public spaces on psychological restoration in older individuals in severely cold regions are highlighted. Across four seasons, the importance of perceived preferences for human activities, landscape features, and facilities varies. During autumn, psychological restoration depends primarily on perceived preferences for human activities, whereas in other seasons, environmental features hold greater importance. These seasonal variations provide valuable insights for enhancing the mental health of older individuals. Despite the novel perspectives in this study, certain limitations remain. To achieve a more comprehensive understanding of the effects of perception preferences on psychological restoration, future research should explore the combined effects of perception frequency and duration.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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